Section 3 Interactions of Waves

Reading Preview

Key Concepts

- How do reflection, refraction, and diffraction change a wave's direction?
- What are the different types of interference?
- How do standing waves form?

Key Terms

- reflection • law of reflection
- refraction • diffraction
- interference
- constructive interference
- destructive interference
- standing wave • node
- antinode • resonance

Target Reading Skill

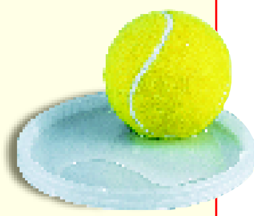
Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what, how, when,* or *where* question for each heading. As you read, write the answers to your questions.

Interactions of Waves

Question	Answer
How are waves reflected?	Waves are reflected . . .

Lab zone Discover Activity

How Does a Ball Bounce?



1. Choose a spot at the base of a wall. From a distance of 1 m, roll a wet ball along the floor straight at the spot you chose. Watch the angle at which the ball bounces by looking at the path of moisture on the floor.
2. Wet the ball again. From a different position, roll the ball at the same spot, but at an angle to the wall. Again, observe the angle at which the ball bounces back.

Think It Over

Developing Hypotheses How do you think the angle at which the ball hits the wall is related to the angle at which the ball bounces back? Test your hypothesis.

You slip into the water in your snorkel gear. With your mask on, you can see clearly across the pool. As you start to swim, your flippers disturb the water, sending ripples moving outward in all directions. As each ripple hits the wall, it bounces off the wall and travels back toward you.

When water waves hit the side of a swimming pool, they bounce back because they cannot pass through the solid wall. Other kinds of waves may interact in a similar way when they hit the surface of a new medium. This type of interaction is called reflection.

Making waves in a pool ▶

Lab zone Discover Activity

Skills Focus Developing hypotheses L2

Materials ball, meter stick, water

Time 10 minutes

Tip If your floor does not show the moisture path well, place paper on the floor for students to roll the wet ball over.

Expected Outcomes The ball will roll to the wall and bounce back, leaving a visible trail of moisture on the floor.

Think It Over The ball bounced back from the wall at the same angle that it hit the wall.

Section 3 Interactions of Waves

Objectives

After this lesson, students will be able to

O.1.3.1 Describe how reflection, refraction, and diffraction change a wave's direction.

O.1.3.2 Distinguish among the different types of interference.

O.1.3.3 Explain how standing waves form.

Target Reading Skill

Asking Questions Explain that when students ask questions about the headings, they are preparing themselves to better understand what they are about to read.

Answers

Sample questions and answers:

1. How are waves reflected? (Waves are reflected when they hit a surface through which they cannot pass and bounce back.)

2. What is refraction? (The bending of waves due to a change in speed)

3. When does diffraction occur? (When a wave moves around a barrier or through an opening in a barrier)

4. What is a standing wave? (A wave that appears to stand in one place, even though it is really two waves interfering)

All in One Teaching Resources

- Transparency O8

Preteach

Build Background Knowledge L2

Experience With Reflection

Help students recall occasions when they saw themselves reflected in a store window or pool of water. Ask: **Why do clear glass and still water act like mirrors?** *(Because they reflect light)* Tell students they will learn more about reflection and other wave interactions in this section.

Instruct

Reflection

Teach Key Concepts L2

Reflection of Waves

Focus Introduce the concept of reflection by holding up a large mirror. Tell students that they can see their faces in the mirror because light waves from their faces are reflected back from the mirror's shiny surface.

Teach Explain that all waves, not just light waves, are reflected whenever they hit a surface they cannot pass through.

Apply Ask: **How can you tell when sound waves are reflected back from a surface?** *(You can hear an echo.)* **learning modality: visual**

Lab zone Build Inquiry L2

Reflecting Light Around a Barrier

Materials flashlight, small mirror

Time 15 minutes

Focus Tell students that light waves do not bend around barriers, such as walls. However, light waves can be reflected in such a way that they bounce around a barrier.

Teach Challenge students to design a plan for using a mirror to reflect the beam of a flashlight around a corner in a hallway. Have them make a sketch showing how they will place the mirror and the angle at which the beam of light will strike it. Let students try their plans.

Apply Ask: **What angles would not work well?** *(Angles much smaller or larger than 45°)* **learning modality: kinesthetic**

Independent Practice L2

All in One **Teaching Resources**

- Guided Reading and Study Worksheet: *Interactions of Waves*

Student Edition on Audio CD

All in One **Teaching Resources**

- Transparency O9

Reflection

When an object or a wave hits a surface through which it cannot pass, it bounces back. This interaction with a surface is called **reflection.** There are many examples of reflection in your everyday life. When you did the Discover Activity, you saw that the ball hit the wall and bounced back, or was reflected. When you looked in your mirror this morning, you used light that was reflected to see yourself. If you have ever shouted in an empty gym, the echo you heard was caused by sound waves that reflected off the gym walls.

All waves obey the law of reflection. To help you understand this law, look at Figure 7. In the photo, you see light reflected off the surface of the sunglasses. The diagram shows how the light waves travel to make the reflection. The arrow labeled *Incoming wave* represents a wave moving toward the surface at an angle. The arrow labeled *Reflected wave* represents the wave that bounces off the surface at an angle. The dashed line labeled *Normal* is drawn perpendicular to the surface at the point where the incoming wave strikes the surface. The angle of incidence is the angle between the incoming wave and the normal. The angle of reflection is the angle between the reflected wave and the normal line. The **law of reflection** states that the angle of incidence equals the angle of reflection.

Reading Checkpoint **What is reflection?**

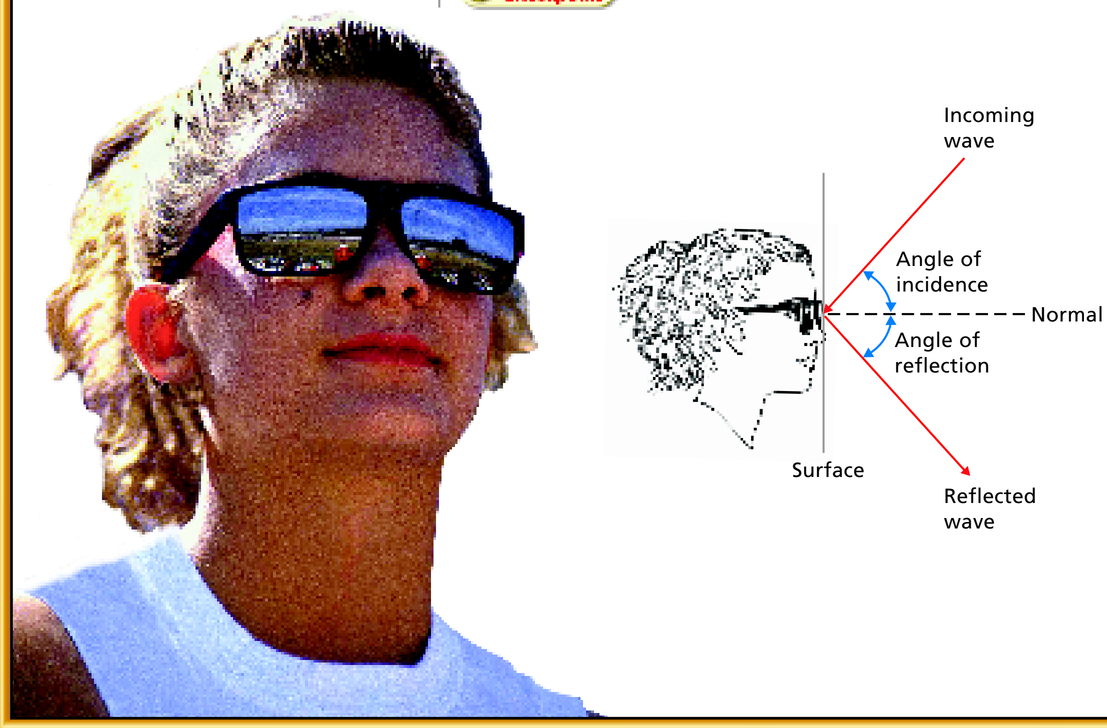


FIGURE 7
Law of Reflection
The angle of incidence equals the angle of reflection. All waves obey this law, including the light waves reflected from these sunglasses.
Predicting *What happens to the angle of reflection if the angle of incidence increases?*

Differentiated Instruction

Gifted and Talented L3

Communicating How Rainbows Form Challenge students to research how and why refraction of white light causes the light to separate into a rainbow of colored light. After researching the problem, students can make an illustrated poster to explain the formation of rainbows to the class. **learning modality: visual**

Special Needs L1

Classifying Wave Interactions Pair special needs students with other students. Have each pair develop a table that classifies wave interactions. For each type of wave interaction, the table should indicate the conditions under which it occurs, how it affects the waves, and an example of when it occurs. **learning modality: visual**

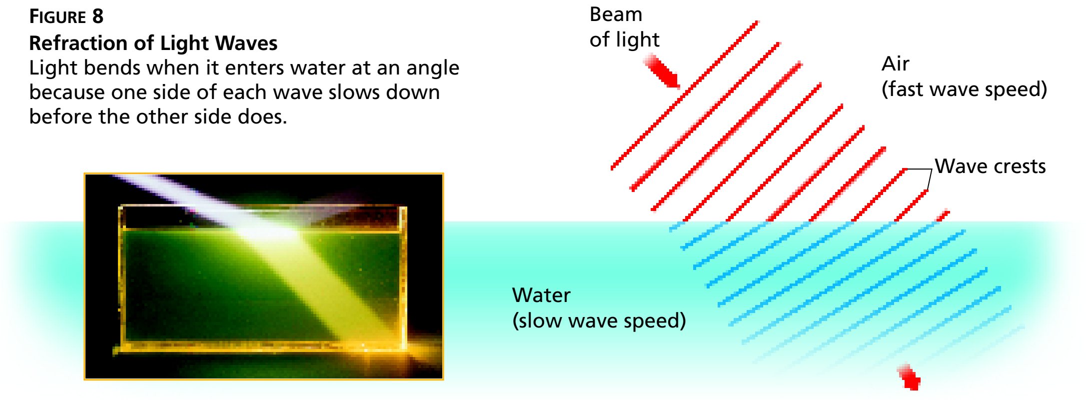


FIGURE 8
Refraction of Light Waves
Light bends when it enters water at an angle because one side of each wave slows down before the other side does.

Refraction

Have you ever been riding a skateboard and gone off the sidewalk onto grass? If so, you know it's hard to keep moving in a straight line. The front wheel on the side moving onto the grass slows down. The front wheel still on the sidewalk continues to move fast. The difference in the speeds of the two front wheels causes the skateboard to change direction.

What Causes Refraction? Like the skateboard that changes direction, changes in speed can cause waves to change direction, as shown in Figure 8. **When a wave enters a new medium at an angle, one side of the wave changes speed before the other side, causing the wave to bend.** The bending of waves due to a change in speed is called **refraction.**

When Does Refraction Occur? A wave does not always bend when it enters a new medium. Bending occurs only when the wave enters the new medium at an angle. Then one side of the wave enters the medium first. This side changes speed, but the other side still travels at its original speed. Bending occurs because the two sides of the wave travel at different speeds.

Even if you don't skateboard, you have probably seen refraction in daily life. Have you ever had trouble grabbing something underwater? Have you ever seen a rainbow? Light can bend when it passes from water into air, making an underwater object appear closer than it really is. When you reach for the object, you miss it. When white light enters water, different colors in the light bend by different amounts. The white light separates into the colors you see in a rainbow.

Reading Checkpoint **When does refraction occur?**

Lab zone Skills Activity

Observing

You can simulate what happens as waves move from one medium to another.

1. Roll a drinking straw from a smooth tabletop straight onto a thin piece of terry cloth or a paper towel. Describe how the straw's motion changes as it leaves the smooth surface.
2. Repeat Step 1, but roll the straw at an angle to the cloth or paper.

Describe what happens as each side of the straw hits the cloth or paper. How are your results similar to what happens when waves are refracted?

Refraction

Teach Key Concepts L2

Refraction of Waves

Focus Define refraction as the bending of a wave due to a change in speed when the wave enters a new medium.

Teach Explain that refraction occurs only when one side of the wave enters the new medium and changes speed before the other side. The wave bends as the two sides of the wave travel at different speeds.

Apply Ask: **What characteristics must a new medium have to cause refraction?** *(It must allow waves to pass through but at a different speed than the original medium.)* **learning modality: verbal**

Use Visuals: Figure 8 L2

Observing Refraction of Light

Focus Have students observe the refraction of light waves in Figure 8.

Teach Point out how the light enters the water at an angle, so the side of the wave entering the water first slows down while the other side maintains its original speed.

Apply Ask: **Would the light be refracted if it entered the water at a 90° angle?** *(No, because both sides would enter the water and slow down at the same time)* **learning modality: visual**

All in One Teaching Resources

- Transparency O10

Monitor Progress L2

Oral Presentation Ask students to explain the difference between reflection and refraction.

Answers

Figure 7 The angle of reflection increases.

Reading Checkpoint Reflection is the interaction in which a wave bounces off a surface through which it cannot pass.

Reading Checkpoint Refraction occurs when a wave enters a new medium at an angle and one side of the wave changes speed before the other side, causing the wave to bend.

Lab zone Skills Activity

Skills Focus Observing L2

Materials drinking straw, piece of terry cloth or paper towel

Time 10 minutes

Tips Demonstrate rolling the straw along the tabletop. Push or blow on the straw so that it rolls by itself. It may help to tape the cloth or towel in place so it does not move if students blow on it.

Expected Outcome The side of the straw that hits the piece of terry cloth or paper towel first slows down first, causing the straw to turn.

Extend Students can experiment with different materials to determine which causes the greatest refraction of the rolling straw. **learning modality: kinesthetic**

Diffraction

Teach Key Concepts L2

Wave Diffraction

Focus Explain that diffraction occurs when waves pass around the edge of, or through a hole in, a barrier.

Teach In Figure 9, have students trace the path of waves as they go around the barrier and through the opening.

Apply Ask: **What happens to waves when they go around a barrier?** *(They bend toward the barrier.)* **When they go through a hole in a barrier?** *(They bend outward and spread out.)* **learning modality: kinesthetic**

Interference

Teach Key Concepts L2

Types of Wave Interference

Focus Define wave interference as the interaction between waves that meet.

Teach On the board, make a table contrasting the two basic types of interference: constructive interference (troughs overlap troughs and crests overlap crests, waves increase in amplitude) and destructive interference (troughs overlap crests, waves decrease in amplitude). Encourage students to make a copy of the table and save it for review.

Extend The ***active art*** will show students the effects of constructive and destructive interference. **learning modality: visual**

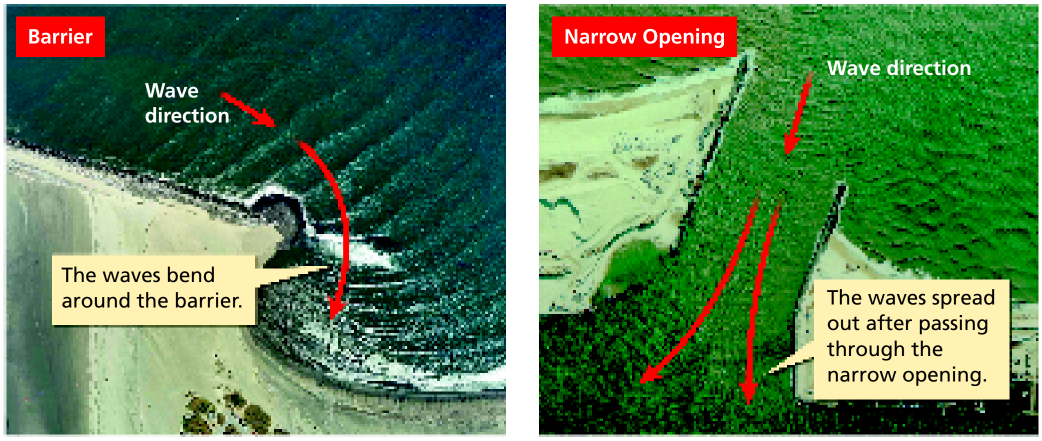


FIGURE 9
Diffraction of Water Waves
Waves diffract when they move around a barrier or pass through an opening. As a wave passes a barrier, it bends around the barrier. After a wave goes through a narrow opening, it spreads out.

Diffraction

Sometimes waves bend around a barrier or pass through a hole. **When a wave moves around a barrier or through an opening in a barrier, it bends and spreads out.** These wave interactions are called **diffraction.** Figure 9 shows how waves bend and spread by diffraction.

Interference

Have you ever seen soccer balls collide in a practice drill? The balls bounce off each other because they cannot be in the same place at the same time. Surprisingly, this is not true of waves. Unlike two balls, two waves can overlap when they meet. **Interference** is the interaction between waves that meet. **There are two types of interference: constructive and destructive.**

Constructive Interference The interference that occurs when waves combine to make a wave with a larger amplitude is called **constructive interference.** You can think of constructive interference as waves “helping each other,” or adding their energies. When the crests of two waves overlap, they make a higher crest. When the troughs of two waves overlap, they make a deeper trough. In both cases, the amplitude increases.

Figure 10 shows how constructive interference can occur when two waves travel toward each other. When the crests from each wave meet, constructive interference makes a higher crest in the area of overlap. The amplitude of this crest is the sum of the amplitudes of the two original crests. After the waves pass through each other, they continue on as if they had never met.

Reading Checkpoint **What is constructive interference?**

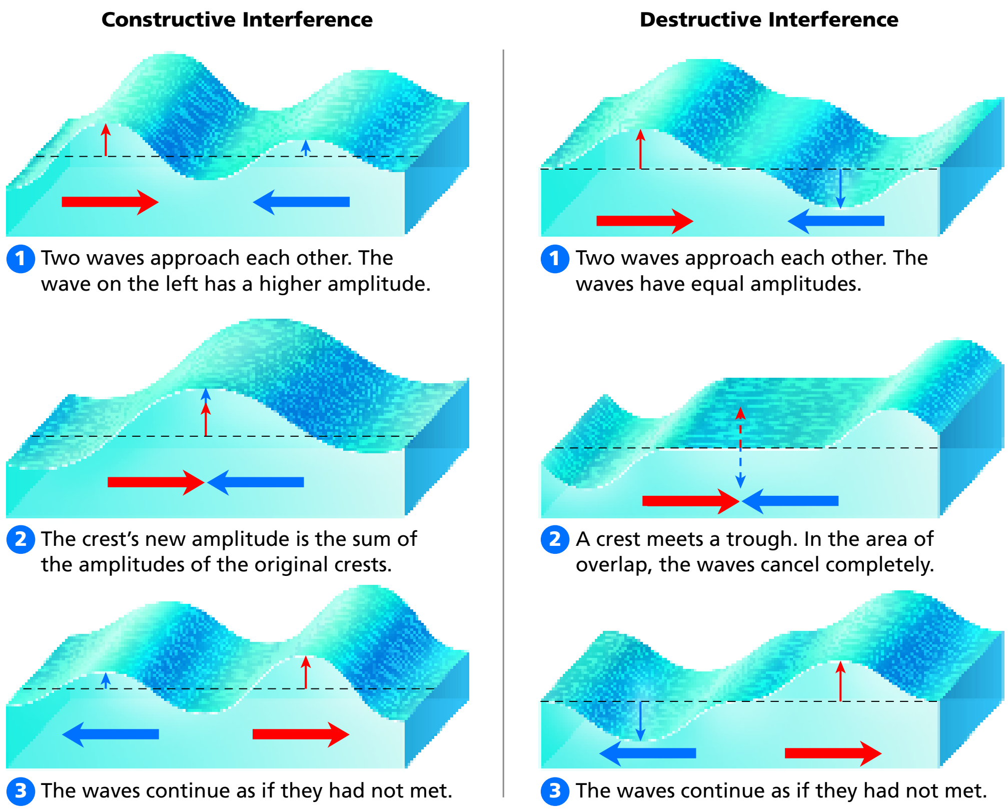
Destructive Interference The interference that occurs when two waves combine to make a wave with a smaller amplitude is called **destructive interference.** You can think of destructive interference as waves subtracting their energies.

Destructive interference occurs when the crest of one wave overlaps the trough of another wave. If the crest has a larger amplitude than the trough, the crest "wins" and part of it remains. If the original trough had a larger amplitude, the result is a trough. If the original waves had equal amplitudes, then the crest and trough can completely cancel as shown in Figure 10.

Go Online
active art

For: Wave Interference activity
Visit: PHSchool.com
Web Code: cgp-5013

FIGURE 10
Wave Interference
Interference can be constructive or destructive.
Interpreting Diagrams *What does the black dotted line represent in the diagram below?*



Lab zone **Build Inquiry** L2

Observing Interference

Materials 1–2 m of rope

Time 15 minutes

Focus Remind students that interference occurs when two waves meet.

Teach Have pairs of students create interference by sending a single pulse through a rope from both ends. First, have both students send upright waves. Then, have one of the students send an inverted wave. Remind students that constructive interference occurs when two crests meet and destructive interference occurs when a crest meets a trough.

Apply Ask: **How is the amplitude of waves affected by constructive interference?** *(It increases.)* **By destructive interference?** *(It decreases.)* **learning modality: kinesthetic**

Go Online
active art

For: Wave Interference activity
Visit: PHSchool.com
Web Code: cgp-5013

Students can investigate the wave interference active art online.

All in One **Teaching Resources**

- Transparency O11

Differentiated Instruction

English Learners/Beginning L1

Vocabulary: Word Analysis On the board, write *constructive* and *destructive* and draw vertical lines to separate *con-* and *de-* from *-struct*. Say that *-struct* means "building," *con-* means "together," and *de-* means "do the opposite." Ask: **What does constructive mean?** *(Building together)* **Destructive?** *(Doing the opposite of building)* **learning modality: verbal**

English Learners/Intermediate L2

Comprehension: Use Visuals Have students identify similarities and differences between the two types of interference shown in Figure 10. Then, based on their observations, have them make a table comparing and contrasting the two types of interference. **learning modality: visual**

Monitor Progress L2

Writing Tell students to describe constructive and destructive interference between waves of different amplitudes.

Answers

Figure 10 The black dotted line represents the rest position of the wave.

Reading Checkpoint Constructive interference is interference that occurs when waves combine to make a wave with a larger amplitude.

Standing Waves

Teach Key Concepts L2

Understanding Standing Waves

Focus Say that a standing wave is a wave that appears to stand in one place. Explain that this is due to wave both constructive and destructive interference.

Teach On the board, write *Destructive Interference, Nodes, Constructive Interference, Antinodes.* Link the first two terms with an arrow. Explain that destructive interference causes nodes, which are points of zero amplitude. Then, link the second two terms with an arrow. Explain that constructive interference causes antinodes, which are points of maximum amplitude. State that nodes are like the troughs of a transverse wave and antinodes are like the crests of a transverse wave.

Apply Remind students that crests have more energy than troughs. Then, ask: **Which parts of a standing wave have more energy, nodes or antinodes?** *(Antinodes)* **learning modality: visual**

Lab zone Teacher **Demo**

Observing Resonance L2

Materials thin crystal drinking glass, water

Time 10 minutes

Focus Tell students that objects have a natural frequency of vibration. When external vibrations match an object's natural frequency, it results in resonance, or an increase in the amplitude of standing waves.

Teach Wet your index finger with water and begin to move your finger around the rim of the glass. Increase the speed of your finger until the glass begins to "hum."

Apply Ask: **What causes the glass to hum?** *(Resonance caused by your finger moving at the same frequency as the natural frequency of the glass)* **learning modality: visual**

All in One **Teaching Resources**

- Transparency O12

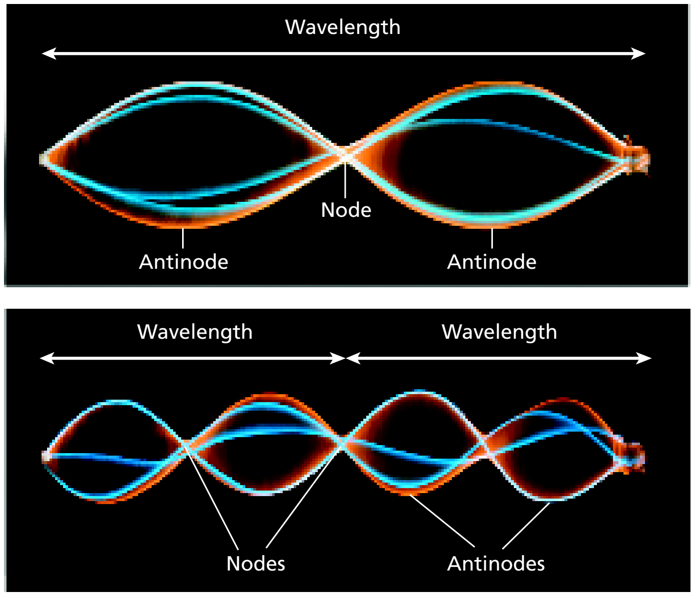


FIGURE 11
Standing Waves
These photos show standing waves in vibrating elastic strings. The photographer used a bright flashing light called a strobe to "stop" the motion.

Lab zone Try This **Activity**

Interfering Waves

1. Place two identical empty bottles near each other. Using a straw, blow gently across the top of one bottle until you hear a sound. Describe the sound.
2. Using two straws, blow across the tops of both bottles at the same time. Describe what you hear.
3. Add a few drops of water to one bottle. Blow across the top of each bottle and note any differences in the sound.
4. Using two straws, blow across the tops of both bottles at the same time.

Observing Describe the sound you heard in Step 4. How did it differ from the sounds you heard in the other steps?

Standing Waves

If you tie a rope to a doorknob and continuously shake the free end, waves will travel down the rope, reflect at the end, and come back. The reflected waves will meet the incoming waves. When the waves meet, interference occurs.

If the incoming wave and a reflected wave have just the right frequency, they produce a combined wave that appears to be standing still. This combined wave is called a standing wave. A **standing wave** is a wave that appears to stand in one place, even though it is really two waves interfering as they pass through each other.

Nodes and Antinodes In a standing wave, destructive interference produces points with an amplitude of zero, as shown in Figure 11. These points of zero amplitude on a standing wave are called **nodes.** The nodes are always evenly spaced along the wave. At points in the standing wave where constructive interference occurs, the amplitude is greater than zero. The points of maximum amplitude on a standing wave are called **antinodes.** These are also the points of maximum energy on the wave. The antinodes always occur halfway between two nodes.

Lab zone Try This **Activity**

Skills Focus Observing L1

Materials two identical empty bottles, two drinking straws, water

Time 10 minutes

Tip Students may need to practice until they can consistently produce a sound with a straw and bottle.

Expected Outcome When both bottles are empty, there is resonance because the bottles have the same frequency. After water is added to one of the bottles, students hear beats because there is an alternating pattern of constructive and destructive interference due to the higher frequency of the bottle with added water.

Extend Have students add water to the empty bottle until there is resonance at the higher frequency. **learning modality: kinesthetic**

Resonance Have you ever pushed a child on a swing? At first, it is difficult to push the swing. But once you get it going, you need only push gently to keep it going. This is because the swing has a natural frequency. Even small pushes that are in rhythm with the swing's natural frequency produce large increases in the swing's amplitude.

Most objects have at least one natural frequency of vibration. Standing waves occur in an object when it vibrates at a natural frequency. If a nearby object vibrates at the same frequency, it can cause resonance. **Resonance** is an increase in the amplitude of a vibration that occurs when external vibrations match an object's natural frequency.

Resonance can be useful. For example, musical instruments use resonance to produce stronger, clearer sounds. But sometimes resonance can be harmful. Figure 12 shows Mexico City after an earthquake in 1985. Mexico City is built on a layer of clay. The frequency of the earthquake waves matched the natural frequency of the clay, so resonance occurred. City buildings 8 to 18 stories high had the same natural frequency. Due to resonance, these buildings had the most damage. Both shorter and taller buildings were left standing because their natural frequency did not match the natural frequency of the clay.

Reading Checkpoint **How can resonance be useful?**

FIGURE 12
Destructive Power of Resonance
In the 1985 earthquake in Mexico City, resonance caused the greatest damage to buildings between 8 and 18 stories tall.
Inferring *Why did taller buildings survive the earthquake?*

Section 3 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** What are three ways that waves change direction?
   b. **Summarizing** How does a wave change direction when it bounces off a surface?
   c. **Relating Cause and Effect** How does a change in speed cause a wave to change direction?
2. a. **Identifying** What are two types of interference?
   b. **Interpreting Diagrams** Look at Figure 10. What determines the amplitude of the wave produced by interference?
   c. **Predicting** Wave A has the same amplitude as wave B. What will happen when a crest of wave A meets a trough of wave B? Explain.
3. a. **Defining** What is a standing wave?
   b. **Explaining** How do nodes and antinodes form in a standing wave?

Lab zone At-Home Activity

Waves in a Sink With your parent's permission, fill the kitchen sink with water to a depth of about 10 cm. Dip your finger into the water repeatedly to make waves. Demonstrate reflection, diffraction, and interference for your family members.

Monitor Progress L2

Answers
Figure 12 Taller buildings survived the earthquake because their natural frequency did not match the natural frequency of the clay and resonance did not occur.

Reading Checkpoint Resonance can produce stronger, clearer sounds in musical instruments.

Assess

Reviewing Key Concepts

1. a. Reflection, refraction, and diffraction **b.** The angle of reflection equals the angle of incidence. **c.** When a wave enters a new medium at an angle, one side of the wave changes speed before the other side, causing the wave to bend.
2. a. Constructive interference and destructive interference **b.** The height of the crest is the sum of the amplitudes of the interfering crests. **c.** The crest and trough will cancel as the waves add their amplitudes at this point.
3. a. A wave that appears to stand in one place, even though it is really two waves interfering as they pass through each other **b.** Destructive interference produces nodes. Constructive interference produces antinodes.

Reteach L1

Write the words *reflection* and *refraction* on the board. Call on students to explain how each process changes light waves. Call on other students to correct any errors.

Performance Assessment L2

Writing Have students write a paragraph comparing and contrasting constructive and destructive interference.

Students can save their paragraphs in their portfolios. Portfolio

All in One Teaching Resources
- Section Summary: *Interactions of Waves*
- Review and Reinforcement: *Interactions of Waves*
- Enrich: *Interactions of Waves*

Lab zone At-Home Activity

Waves in a Sink L2 Suggest that students first use a floating cork to show the difference between the wave and the medium. Also, suggest that they describe each wave interaction before demonstrating it to family members. Allow a few students to show the class how they demonstrated wave interactions at home.

Lab zone Skills Lab

Making Waves

L2

Prepare for Inquiry

Skills Objectives

After this lab, students will be able to

- model wave behavior
- observe waves under varying conditions
- control variables to produce waves with different properties
- interpret data and draw conclusions about wave behavior

Prep Time 30 minutes

Class Time 40 minutes

Advance Planning

Prepare the ripple tanks and have the other materials available.

Safety

Tell students to clean up all spills immediately and to be careful handling wet mirrors. Review the safety guidelines in Appendix A.

All in One Teaching Resources

- Lab Worksheet: *Making Waves*

Guide Inquiry

Invitation

Show a video of ocean waves or have students discuss waves they have seen. Ask them to describe the size of the waves and what happened when the waves met.

Introduce the Procedure

Tell students they will observe waves they make in a ripple tank. Show them a ripple tank filled with water and demonstrate how to generate waves. Call their attention to the reflection of the waves that they can see in the mirror on the bottom of the tank.

Lab zone Skills Lab

Making Waves

Problem

How do water waves interact with each other and with solid objects in their paths?

Skills Focus

observing, making models

Materials

- water
- plastic dropper
- metric ruler
- paper towels
- modeling clay
- cork or other small floating object
- ripple tank (aluminum foil lasagna pan with mirror at the bottom)

Procedure

1. Fill the pan with water to a depth of 1.5 cm. Let the water come to rest. Make a data table like the one shown in your text.
2. Fill a plastic dropper with water. Then release a drop of water from a height of about 10 cm above the center of the ripple tank. Observe the reflection of the waves that form and record your observations.
3. Predict how placing a paper towel across one end of the ripple tank will affect the reflection of the waves. Record your prediction in your notebook.
4. Drape a paper towel across one end of the ripple tank so it hangs in the water. Repeat Step 2, and record your observations of the waves.
5. Remove the paper towel and place a stick of modeling clay in the water near the center of the ripple tank.

Data Table

Type of Barrier	Observations Without Cork	Observations With Cork

6. From a height of about 10 cm, release a drop of water into the ripple tank halfway between the clay and one of the short walls. Record your observations.
7. Place the clay in a different position so that the waves strike it at an angle. Then repeat Step 6.
8. Place two sticks of clay end-to-end across the width of the tank. Adjust the clay so that there is a gap of about 2 cm between the ends of the two pieces. Repeat Step 6. Now change the angle of the barrier in the tank. Again repeat Step 6, and watch to see if the waves interact with the barrier any differently.

Troubleshooting the Experiment

- Point out the weaker reflected waves so students do not overlook them.
- Make sure students can correctly identify the crests and troughs of the waves.

Expected Outcome

Students can control wave amplitude, frequency, and wavelength by changing the methods they use to produce the waves. Students can also model, observe, and describe different types of wave interactions.

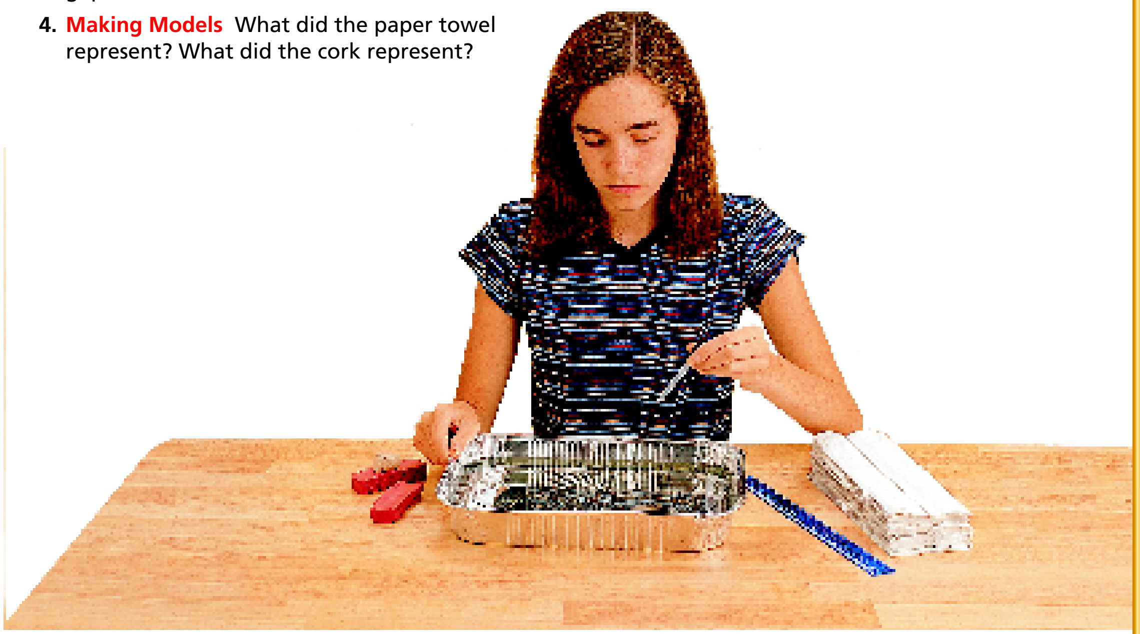
9. Cut the two pieces of clay in half. Use the pieces to make a barrier with three 2-cm gaps. Then repeat Step 6.
10. Remove all the clay and add a small floating object, such as a cork, to the water. Then repeat Steps 2–9 with the floating object. Observe and record what happens to the cork in each step.
11. Once you have finished all of the trials, clean and dry your work area.

Analyze and Conclude

1. **Observing** How are the waves affected by the paper towel hanging in the water?
2. **Observing** What happens when the waves strike a barrier head on? When they strike it at an angle?
3. **Observing** What happens when the waves strike a barrier with a gap in it? With three gaps in it?
4. **Making Models** What did the paper towel represent? What did the cork represent?
5. **Applying Concepts** How does the behavior of waves in your model compare to the behavior of waves in a harbor?
6. **Communicating** Evaluate your model. Write a paragraph about the ways your model represents a real situation. Then write a paragraph about your model's limitations.

More to Explore

Predict what would happen if you could send a steady train of uniform waves the length of the ripple tank for an extended time. Use a plastic bottle with a pinhole in the bottom to make a dropper that will help to test your prediction. Get permission from your teacher to try out your dropper device.



Extend Inquiry

More to Explore Students may predict that standing waves would occur. Sending uniform waves at a regular frequency makes it easier to observe wave properties and interactions. Students can increase the size of the hole in the bottle to produce more frequent waves and observe how this affects other wave properties.

Analyze and Conclude

1. The wet paper towel absorbs the wave's energy. Either there is no reflected wave or the reflected wave is much weaker than the original wave.

2. When waves strike a barrier head on, the waves are reflected straight back, meeting the incoming waves and causing interference. When waves strike a barrier at some other angle, the waves are reflected back at the same angle but in the opposite direction.

3. Diffraction occurs when a wave hits a barrier with a gap in it. Part of the wave passes through the gap and spreads throughout the water on the other side of the barrier. The rest of the wave is reflected back from the barrier. When a wave hits a barrier with three gaps, three sections of the incoming wave pass through the barrier, and three small waves spread throughout the water on the other side of the barrier, growing wider and wider.

4. The paper towel represented a shoreline of sand or vegetation, materials that absorb some of the wave's energy. The cork represented an object floating in the water, such as a buoy, boat, or person.

5. The behavior of waves in the model is similar to the behavior of waves in a harbor. The waves in a harbor, however, would have more complex interactions.

6. Answers will vary. Ways the model represents a real situation might include the types of wave interactions. Limitations might include the small size of the water surface and the absence of currents and other water disturbances.